REMARKS

Reexamination and reconsideration of the claims 1-12 are respectfully requested. Applicants appreciate and acknowledge the Examiner's consideration of all the references on the IDS. **Additionally, Applicants submit herewith a substitute specification under 37 CFR 1.125 along with a marked-up version. No new matter has been added to the substitute specification.**

The drawings were objected to under 37 C.F.R. 1.83(a) for not showing the slot element surrounding the optical waveguides as described in the specification. Applicants respectfully assert that the Figures schematically illustrate the slot element. Moreover, the substitute specification submitted herewith remedies the objection. Withdrawal of the objection to the drawings is respectfully requested.

The disclosure was objected to due to informalities. The substitute specification submitted herewith corrects the informalities. Withdrawal of the objection to the specification is respectfully requested.

The Office Action objected to claims 1 and 7. Claims 1 and 7 have been amended along with the other claims to improve readability of the same. Moreover, the amendment of claims 1 and 7 (or any other claim) is not an admission that the art of record teaches, discloses, or otherwise suggests any features of the claims. Withdrawal of the objection to claims 1 and 7 is respectfully requested.

Claims 1 and 7 were rejected under 35 U.S.C. sec. 112, first paragraph, as not disclosing the best mode. The Office Action states "[e]vidence of concealment of the best mode is based upon the lack of disclosure on the specificity of the filling compound and the extruding process that will form an optical fiber with multiple cores wherein the refractive index of the core is higher than the refractive index of the cladding." Additionally, web page titled "Fiber 101" was cited on the PTO-892 and included

with the Office Action.

It is respectfully submitted that the sec. 112, first paragraph rejection misinterprets the present invention. The sec. 112 rejection, first paragraph, suggests that the invention uses the filling material as light waveguide. Instead, the present invention is directed to applying a filling material in a liquid state to at least one optical fiber that thereafter expands to cushion and couple the same within the slot element, thereby replacing the traditional grease or messy gel typically disposed within the slot tube that must be removed when working with the optical fiber. Moreover, one of ordinary skill in the art would have understood the concepts of the present invention and would have realized that the specification does not deal with refractive indices of materials as suggested in the rejection. Furthermore, one of ordinary skill in the art at the time of the invention would have been able to select suitable polyurethane or silicone based materials to be applied in a liquid state that would then expand. Withdrawal of the sec. 112 rejection, first paragraph, of claims 1 and 7 is respectfully requested.

Claims 1, 3-4, and 7 were rejected under 35 U.S.C. sec. 112, second paragraph, as being incomplete for omitting essential elements (e.g. cladding AH'). The substitute specification addresses the use of reference characters and terminology in the specification, thereby correcting the matter. Withdrawal of the sec. 112 rejection, second paragraph, of claims 1, 3-4 and 7 is respectfully requested.

Claim 6 was rejected under 35 U.S.C. sec. 112, second paragraph, as being indefinite. Claim 6 has been amended. Withdrawal of the sec. 112 rejection, second paragraph, of claim 6 is respectfully requested.

Claims 1-3, 7-8, and 10 were rejected under 35 U.S.C. sec. 102(b) applying U.S. Pat. No. 6,658,184 (the '184 patent). For a patent to be applicable under sec. 102(b), the patent must, *inter*

alia, disclose each and every feature of the claimed invention.

It is respectfully submitted that the '184 patent was misinterpreted since it does not teach, disclose, or otherwise suggest each and every feature of independent claim 1. Specifically, the '184 patent is directed to a flexible tube or "skin" that surrounds the optical fibers and can easily be torn. <u>See</u> Cols. 1-2, ll. 60-37 of the '184 patent. At Col. 2, ll. 52-60, the '184 patent states:

> FIG. 1 is a section view of a telecommunications cable module 1 comprising at least one and generally a plurality of optical fibers 2. The optical fibers 2 are surrounded by a flexible tube 4 referred to as a "skin". The gaps between the fibers are general[ly] occupied by a hydrophobic gel 3, e.g. based on silicones.
> It is also possible to use a powder that swells, or to leave nothing between the fibers. The skin 4 is applied to the set of optical fibers, e.g. by extrusion.

In other words, the '184 patent discloses using a traditional hydrophobic gel (i.e. a grease-like material) or water-swellable powder within tube 4. Neither the hydrophobic gel, nor the swellable powder, are applied as a liquid and thereafter expand within tube 4 as recited in claim 1. The skilled artisan would have understood that the swellable powder discussed in the '184 patent is a water-swellable powder for blocking the migration of water if it ever enters tube 4. Simply stated, the swellable powder remains a powder within the tube until a liquid such as water enters the tube. Moreover, the entry of water into the tube is an undesirable event and is preferably avoided for the life of the cable. Likewise, the '184 patent does not disclose each and every feature of independent claim 7. For at least this reason, the withdrawal of the sec. 102(b) rejection of claims 1-3, 7-8, and 10 is warranted and respectfully requested.

Claims 4-6 and 11-12 were rejected under 35 U.S.C. sec.

103(a) applying the '184 patent in view of U.S. Pat. No. 5,393,536 (the '536 patent). To be applicable under sec. 103(a), the combination of teachings must, *inter alia*, expressly or inherently, teach, disclose, or otherwise suggest each and every feature of the claimed invention. Additionally, motivation and suggestion to combine the patents must be present.

First, as discussed above, none of the materials within tube 4 of the '184 patent are applied as a liquid and then expand within the tube. Second, it is respectfully submitted that the skilled artisan would not have been motivated, nor taken a suggestion, to combine the patents for the reason provided in the Office Action since the '184 is not a suitable design for a submarine cable.

Third, the '536 patent is directed to a method and apparatus for making reinforced extrusion products for use as structural materials, whereas the skilled artisan would have understood that fiber optic cables are not structural materials. Consequently, there is not a reasonable expectation of success even if the purported modification were made. Because the extruded products of the '536 patent are intended as structural materials they have certain physical characteristics including density, strength, coefficient of linear expansion, etc. See Col. 7, ll. 15-22 of the '536 patent and the p. 6 of the Office Action.

In other words, the skilled artsian would have understood that the filling material should, for instance, be rigid and relatively dense. These physical characteristics would not be suitable for use in tube 4 of the '184 patent since it would result in a tube assembly that would not operate properly. For instance, the tube of the purported modification would be to stiff to bend and coil properly and it would be relatively heavy. Also, the "skin" of the '184 patent is thin and easily torn so having a material expand therein may be problematic. Likewise, the fillers in the material may stretch or tear the skin.

Moreover, these properties would mostly likely cause elevated levels of optical attenuation, thereby rendering the tube assembly inoperable for its intended purpose of transmitting optical signals for communication purposes. Consequently, the skilled artisan would not have had a reasonable expectation of success with respect to the purported modification. Thus, the purported modification failed to make a *prima facie* case with respect to the claims. For the reason stated above with respect to claim 1, the withdrawal of the sec. 103(a) rejection of claims 4-6 and 11-12 is warranted and respectfully requested.

No fees are believed due in connection with this Reply. If any fees are due in connection with this Reply, please charge any fees, or credit any overpayment, to Deposit Account Number 19-2167.

Allowance of all pending claims is believed to be warranted and is respectfully requested.

The Examiner is welcomed to telephone the undersigned to discuss the merits of this patent application.

Respectfully submitted,

Michael E. Carroll, Jr.
Attorney
Reg. No. 46,602
P.O. Box 489
Hickory, N. C. 28603
Telephone: 828/901-6725

Date: December 8, 2005

PROCESS FOR MANUFACTURE OF AN OPTICAL TRANSMISSION ELEMENT WITH SEVERAL DRY AND COMPRESSIBLE FILLING ELEMENTS AS WELL AS OPTICAL TRANSMISSION ELEMENT

FIELD OF THE INVENTION

The present invention concerns a process for the manufacture of an optical transmission element with several optical waveguides and with a slot element surrounding the optical waveguides, which encloses an interior space, as well as with several dry and compressible filling elements, which are arranged within the interior space of the slot element. The invention further concerns such an optical transmission element.

BACKGROUND OF THE INVENTION

Optical transmission elements such as optical cables or optical cores, for example, in the form of so-called bundles, in general contain optical waveguides which are surrounded by a slot element enclosing them. A usual method for anchoring the optical waveguides in an optical transmission element is filling the slot elements with high-viscose, thixotropic or cross-linked filling compound. Such a filling compound has the disadvantage, that it can leak out or drip out in case of vertically hanging ends of the transmission element. Additionally, in case of splitting the transmission element during installation, leaking filling compound can lead to contamination and handling problems on the part of the installation personnel.

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Such a filling of the optical transmission element has the advantage, that during the manufacturing process of the optical transmission element during the extrusion of the slot element in the form of a tube, the still soft cladding of the tube is supported by the filling compound and the round cross-section remains stable until curing occurs. Furthermore,

water, which penetrates due to damage to the transmission element into the tube, is prevented by the filling compound from further penetration.

Water tightness of the transmission element can also be produced, when the slot tube of the transmission element is only filled with filling compound in sections or with several dry and compressible filling elements, which provides the additional advantage, that costs of filling compound can be reduced. However, a disadvantage of this sectional filling of the transmission element is a discontinuation of the support effect for the still soft slot tube immediately after extrusion. Without additional procedures, this can lead to sections of non-round slot tubes, which at least complicate or prevent a symmetrical cable construction or core construction, respectively.

In order to get a round cross-section of an optical transmission element without continuous filling compound, so-called outer calibration can be used as an additional procedure. With this, the soft slot tube is pulled through a slot, where there is a vacuum relative to the environment. This vacuum sucks the slot walls towards the outside against the inner contours of so-called disc tips, past which they are pulled and then cured. Such outer calibrations devices are generally technically difficult to produce and have to be calibrated for each outer diameter of a transmission element.

SUMMARY OF THE INVENTION

The present invention has the objective to specify a process for the manufacture of an optical transmission element, with which an optical transmission element with an extruded slot element filled in sections can be produced without the cross-section of the slot element being changed during the manufacturing process.

Beyond this it is the objective of the present invention to specify a corresponding optical transmission element.

This objective is achieved by a process for the manufacture of an optical transmission element according to the invention and by an optical transmission element according to the invention.

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In the process according to the invention a filling compound is intermittently applied in a liquid state to the optical waveguide being guided to an extruder. The optical waveguides with the applied filling compound are subsequently fed into the extruder, where the extruder forms a slot element around the optical waveguides. The applied filling compound expands within the formed slot element, where the interstices present in the interior are penetrated on the cross-section level by the filling compound and where several dry, compressible filling elements are formed in the final state, which each surround the optical waveguides.

With the use of the process according to the invention, the cross-section of the optical transmission element with the extruded slot element is not impaired during the manufacturing process. This is accomplished by the fact, that the filling compound applied in a liquid state is comparatively compactly placed on the optical waveguides and bathes them and only expands within the formed slot element, so that the slot element can cure after extrusion, before the expanding filling compound comes in contact with the

inner wall. This foaming of the filling compound is delayed long enough until the liquid filling compound is located within the extruded slot elements. In particular, the filling compound within the formed slot element begins to expand only after leaving the extruder, preferably only then, when the slot element is in a cured state. Polyurethane or silicones can possibly be used for the filling compound.

Thus the end product is an optical transmission element with several optical waveguides and a slot element surrounding the optical waveguides, where several dry and compressible filling elements are placed within the interior of the slot element, which are formed by a material, which expands in the interior. A defined contact pressure is exerted by the filling elements in the foamed state against the slot element and against the optical waveguides for anchoring the same in the longitudinal direction of the transmission element, where change of position of the optical is nevertheless possible. The filling elements each surround the optical waveguides, and interstices present between the optical waveguides in the cross-section level of the optical transmission element are completely filled and penetrated by the subsequently expanding filling compound. In addition, the optical waveguides and the slot element are essentially in all-around contact with the filling elements.

Further advantageous constructions and developments of the invention are given in the sub claims.

BRIEF DESCRIPTION OF THE FIGS.

The invention is further explained by means of the figures displayed in the drawing, which show construction samples of the present invention.

Shown is:

Figure 1 is a cross-section diagram of an optical transmission element according to the invention during manufacture and in the final state

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Figure 2 is a longitudinal section of an optical transmission element according to the invention in the final state,

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Figure 3 is a schematic diagram of a manufacturing line for the manufacture of an optical transmission element according to the process of the invention.

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DETAILED DESCRIPTION OF THE INVENTION

In Figure 1 a cross-section diagram of an optical transmission element according to the invention is shown during manufacture (left figure) and in the final state (right figure). In the left diagram of Figure 1 it can be seen, that several optical waveguides LW are arranged within the slot element AH' such as the slot tube shown, which is formed around the optical waveguides LW. The optical waveguides LW in this sample are optical fibers, which are arranged as a fiber bundle within a bundle core with the slot element AH'. The slot element AH' of the bundle core OA' is still in a relatively soft state and is not yet in contact with the filling compound FM' applied to the fiber bundle in a liquid state. An alternate construction gives optical cores with several fibers, which are each enclosed, as optical waveguides, where the cores are arranged as core strands within the cable jacket with the slot element AH'. The invention is further described in the following by means of the first construction sample.

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In the right part of Figure 1 the cured bundle core OA is shown in contrast, where the slot element AH is in a rigid state. By means of the meanwhile foamed filling compound FM a filling element FE is formed in the final state, which exerts a defined contact pressure against the slot element AH and against the optical fibers LW for anchoring of the same in the longitudinal direction of the bundle core OA, where change of position is nevertheless possible. By the subsequent expansion of the filling compound FM interstices present between the optical fibers LW in the cross-section level of the bundle core OA are completely filled and penetrated, as well as interstices between the optical fibers LW and the slot element AH. Filling compounds based especially on polyurethane or silicones can be used here.

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Figure 2 shows a longitudinal section of an optical transmission element according to the invention according to Figure 1 in the final state. By means of the filling compound applied intermittently to the optical fibers LW, which expands within the slot element AH, several dry and compressible filling elements FE1 to FE3 are formed, which surround the optical fibers LW and completely fill and penetrate interstices present between the optical fibers in the cross-section level of the bundle core OA. Between the filling elements FE1 to FE3, intermediate interstices ZW not occupied by filling elements are arranged. Thus a dry bundle core OA is created, in whose interior filling elements FE1 to FE3 functioning as partitions are arranged, which provide an effective longitudinal water tightness for the bundle core. To enhance this characteristic, the filling elements FE1 to FE3 can contain a medium for sealing against penetrating water, which swells when water enters.

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Figure 3 shows a schematic diagram of a manufacturing line, which manufactures an optical transmission element especially in the form of a bundle core by the process according to the invention. A bundle of optical fibers LW is guided to an extruder EX. During this process a filling compound FM' ' is intermittently applied to the fiber bundle

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in liquid state. The fiber bundle is subsequently fed into the extruder EX, where the slot element AH' is formed by the extruder EX around the fiber bundle. The filling compound FM' ' is employed as a wetting agent and also penetrates into the cavities between the fibers of the fiber bundle. The filling compound FM' ' is applied intermittently and in a thin layer, which is not yet sufficient for sealing the bundle core. After a preset delay period and/or with assistance of heat supply the still liquid filling compound FM' ' (foaming filling compound FM') expands, where the timing of the foaming is selected in such a way, that the slot element AH' can no longer be deformed by the expanding foam. In particular, the filling compound FM' begins to expand only after leaving the extruder EX, preferably only then, when the slot element AH is in a rigid state. Immediately after leaving the extruder EX the newly extruded slot element AH is still in a soft state.

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The delay period between the application of the filling compound and the beginning of the expansion of the filling compound is set depending on the pay-off speed of the bundle core AH, which is taken off in the pay-off direction AR. The delay period is preferably set between one and a maximum of 300 seconds. The expanding filling compound FM' ', FM' penetrates interstices present in the interior of the core cladding AH in the cross-section level of the bundle core and forms a dry, compressible filling element FE in the final state, which is formed by the completely expanded filling compound FM.

The application of the filling compound, which forms the later filling elements, onto the incoming optical waveguides in front of the extruder has the additional advantage, that the exact dosage is significantly simplified. Suitable dosing valves and dosing pins, even of larger design, can be brought into immediate proximity of the optical waveguides in front of the extruder. Behind the extruder it can be implemented only within a hollow tube and is technically difficult due to the small physical dimensions.

The invention thus makes it possible to manufacture an optical transmission element with a slot tube filled in sections, without changing the cross-section of the slot element by the sectional filling during manufacture. Thus an outer calibration required until now can be eliminated and the material-saving sectional filling of the slot element can be used. Besides the sectional filling of the slot element, the expanding of the filling compound provides a further saving in material.

The expanded filling compound adds only a small weight increase to the finished transmission element. It can be removed from the optical waveguides easily and completely without additional tools and thus eases the installation and connectorization of a cable. The expanded filling compound is made in such a way, that it seals the interstices within the fiber bundle and between fiber and slot wall watertight in the cross-section level of the bundle core, but that the fibers can be pulled through it easily. The filling compound stopper in the form of each filling element remains after pulling out the fibers. The fibers are clean and without residue and can be used immediately for further installation (splicing, depositing in cartridges) without additional cleaning procedures.

THAT WHICH IS CLAIMED:

1. Process for the manufacture of an optical transmission element with several optical waveguides and with a slot element surrounding the optical waveguides, which seals an interior space,

- where a filling compound is applied intermittently to the optical waveguides in liquid state,

- the optical waveguides are subsequently fed into an extruder, where the extruder forms a slot element around the optical waveguides,

- where the filling compound expands within the formed slot element, penetrates interstices present in the interior in the cross-section level of the transmission element and forms several dry, compressible elements in its final state, which each surround the optical waveguides.

2. Process according to claim 1, wherein polyurethane or silicones being used as the filling compound.

3. Process according to claim 1, wherein the slot element not being changed during the expanding process in its cross-section by the expanding filling compound.

4. Process according to claim 1, wherein the filling compound within the formed slot element beginning to expand only after leaving the extruder, preferably only when the slot element is in a rigid state.

5. Process according to claim 4, wherein the delay period between application and the beginning of expansion of the filling compound being set dependent on the pay-off speed of the slot element, amounting preferably to at least one and a maximum of 300 seconds.

6. Process according to claim 1, wherein the expansion of the filling compound being initiated and/or aided by a supply of heat.

7. Optical transmission element

- with several optical waveguides and with a slot element surrounding the optical waveguides, which seals an interior space,
- with several dry and compressible filling elements, which are arranged in the interior space and are formed by material expanding within the interior space, where a defined contact pressure is applied by the filling elements against the slot element and against the optical waveguides for anchoring them in longitudinal direction of the transmission element and where position changes of the optical waveguides are possible,
- where the filling elements each surround the optical waveguides, completely fill and penetrate interstices between the optical waveguides present in the cross-section level of the transmission element and are essentially in all-around contact with the optical waveguides and the slot element.

8. Optical transmission element according to claim 7, wherein the material of the filling elements being made of polyurethane or silicones.

9. Optical transmission element according to claim 7, wherein the filling elements being made of a material expanding starting from a liquid state.

10. Optical transmission element according to claim 7, wherein several separate filling elements being arranged in the longitudinal direction of the optical transmission element with intermediate interstices not being occupied by filling elements.

11. Optical transmission element according to claim 7, wherein the filling elements containing a medium for sealing, which swells during water penetration.

12. Optical transmission element according to claim 7, wherein the filling elements being made in such a way, that they can be removed from the optical waveguides easily and completely without using additional tools.

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ABSTRACT OF THE DISCLOSURE

In a process for the manufacture of an optical transmission element with several optical waveguides and with a slot element each surrounding the optical waveguides, a filling compound is applied intermittently to the optical waveguides in a liquid state. The optical waveguides are subsequently fed into an extruder, where the extruder forms a slot element around the optical waveguides. The filling compound expands only within the formed slot element, so that interstices present in the cross-section level of the transmission element are penetrated and several dry, compressible filling elements are formed, disposed about the respective optical waveguides. With the process according to the invention, the cross-section of the extruded slot element is not compromised during the manufacturing process.

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